HYDROGEOMORPHIC EVALUATION OF ECOSYSTEM RESTORATION AND MANAGEMENT OPTIONS FOR SEEDSKADEE NATIONAL WILDLIFE REFUGE

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EXECUTIVE SUMMARY

This study provides an evaluation of ecosystem restoration and management options for Seedskadee National Wildlife Refuge (NWR) in southwestern Wyoming using Hydrogeomorphic Methodology (HGM). The HGM evaluation obtained and analyzed historical and current information about: 1) geology and geomorphology, 2) soils, 3) topography and elevation, 4) hydrology, 5) plant and animal communities, and 6) physical anthropogenic features of the Seedskadee ecosystem.

Seedskadee NWR contains about 27,230 acres along 36 miles of the Green River downstream from Fontenelle Reservoir. The current surficial geology of the refuge reflects the complex geological history of the region and contains the active Holocene-derived Green River channel and floodplain, the structural terrace of the Bridger Formation, relict alluvium of tributary channels, and alluvial fans eroded from surrounding uplands. Contemporary soil data and maps are not available for the refuge, but gross-scale soil maps prepared for the refuge in 1957 indicate a heterogeneous distribution of soil types with moderately deep sandy loam alkaline soils in the Green River floodplain, deep clay alkali soils on alluvial fans, intermingled gravel and shallow loam soils on recent terraces, and clay saline and shallow gravelly soils on upland terraces and benches. Recent LIDAR topographic surveys were conducted on the refuge during 2010 and provide detailed elevation information for the area.

The climate of southwestern Wyoming is desert steppe with low average annual precipitation (6.48 inches) and a short 103-day growing season. Evapotranspiration is about 3-5 times annual precipitation. The Green River and its major tributaries, especially the Big Sandy River, historically were the primary sources of surface water at Seedskadee NWR. River and stream flow characteristics are influenced by annually dynamic snowpack in the watershed. Mean

annual Green River flows upstream of Seedskadee NWR prior to Fontenelle Reservoir identify dynamic annual peak flows, mainly in June, and that Green River flows capable of causing substantial flooding of floodplains on Seedskadee NWR were common. Historically, a Green River discharge of > 10,000 cfs upstream from Seedskadee NWR occurred in about half of all years. Discharges of at least 15,000 cfs occurred about once every 4-5 years and flood events of > 20,000 cfs occurred in 3 of 36 years at Green River, Wyoming from 1898 to 1922.

Various data and analyses indicate that a Green River discharge of about 8,000 to 10,000 cfs causes water from the river to enter low elevation floodplain swales on Seedskadee NWR. Aerial photographs during a 16,800 cfs event on the Green River in September 1965 indicated widespread flooding on the refuge prior to when most levees and water-control structures on the refuge were present. Models of potential flooding distribution on Seedskadee NWR were prepared using visual estimates of the distribution of historical flooding and hydraulic analysis with HEC-RAS. Visual models used LIDAR topographic data, stage-discharge relationships up to 14,000 cfs, and the 1965 aerial photographs. HEC-RAS models used steady-state water surface profile computations, energy-loss equations, and LIDAR. The modeled distribution of flood inundation was similar between the visual and HEC-RAS methods in areas where water-control infrastructure developments were limited, but varied to some degree where extensive dike construction has occurred and in areas that were flooded when LIDAR was flown. Despite some data limitations, both models identified patterns of historical and contemporary flood frequency based on location in the floodplain, past river migration routes, and river stage. Typically, floodwaters tend to enter floodplain bottoms in the Upper Green River from the downstream end of point bars, floods old river channels and floodplain swales first, and then floodwaters gradually inundate higher floodplain ridges, swales, and terraces. At discharges > 14,000 cfs, water from the Green River begins to overtop upstream river bend areas and natural levees and connects upstream flood headwaters with downstream backwaters.

Seedskadee NWR contains relatively narrow floodplains along the Green and Big Sandy Rivers embedded within a sagebrush-dominated upland steppe landscape. Areas

adjacent to the Green River channel historically contained linear bands of riparian woodland, especially on the insides of river bend point bars. Floodplain meander scrolls, high flow channels, and depressions historically contained wetlands ranging from small areas of persistent emergent vegetation communities in deeper more frequently flooded sites to seasonally flooded sedge-rush communities in shallow sites. Upland areas at Seedskadee NWR historically were dominated by sagebrush-steppe communities. A hydrogeomorphic matrix of relationships of vegetation communities to geomorphic surface, soils, topography, and hydrology was developed to map the potential distribution of Presettlement communities at Seedskadee NWR. Generally, historical (and current) vegetation communities at Seedskadee NWR were arrayed as "bands" or "zones" from the Green River channel to the uplands on the edges of the floodplain and their distribution was strongly defined by the combination of elevation and hydrology. Most wetland habitats historically on the refuge were seasonally flooded types. Diverse animal communities historically were present in the various habitats at Seedskadee NWR. The historic nature of wetlands on the refuge, provided mainly spring and early summer flooding that was most beneficial to spring migrant waterbirds. More extensive summer flooding and breeding habitat was limited to small deep floodplain depressions, such as abandoned river channels, and in wet years.

This study obtained contemporary information on: 1) physical features, 2) land use and management, 3) hydrology, 4) vegetation communities, and 5) fish and wildlife populations on Seedskadee NWR where available. These data chronicle the history of land and ecosystem changes at and near the refuge from the Presettlement period and provide perspective on when, how, and why alterations have occurred to ecological communities and processes on the refuge. The major changes in the Seedskadee NWR ecosystem since the late-1800s have been: 1) alterations to the distribution, chronology, and abundance of surface and groundwater, especially following construction and subsequent operation of Fontenelle Reservoir; 2) alteration of native sagebrush-steppe and grassland communities from intensive livestock grazing; 3) reduced and altered riparian woodland; and 4) altered topography including many levees, roads, ditches, borrow areas, and water-control structures.

Since establishment of the refuge in 1965, many wetland developments have occurred; the most substantial water-control infrastructure was built or rehabilitated in the 1980s in the Hamp, Hawley, Lower Hawley, Cottonwood, Pal, and Dunkle impoundments. Management of these impoundments typically has sought to flood pools in mid-March and then to maintain full pool levels through summer and fall to provide breeding and fall migration habitat for waterbirds, especially dabbling ducks and trumpeter swans. A consequence of the annual semipermanent to permanent flooding of impoundments has been an increase in coverage of persistent emergent vegetation, primarily cattail, and decreased wetland and waterbird productivity.

Invasive plant species have expanded greatly in many floodplain and some upland areas on Seedskadee NWR. Biological, mechanical, and chemical control methods have been used to manage these invasive plants. Older cottonwood stands in riparian areas are deteriorating rapidly and little new recruitment is occurring. Several attempts have been made to restock cottonwood in select riparian sites using direct planting and fencing of saplings, but with minimal success.

The future condition of the Seedskadee NWR ecosystem is, and will continue to be, highly affected by the presence and operation of Fontenelle Reservoir and Dam. The impetus for establishing Seedskadee NWR was to mitigate fish and wildlife habitat losses from the reservoir (and other older proposed diversions of water from the Green River). Consequently, future management of Seedskadee must attempt to sustain and restore historical communities and resources in this region of the Green River Valley and to manage all habitats (sagebrush-steppe, floodplain wetlands, riparian woodland, riverine) to provide historical resources used and required by native animal species within the constraints imposed by the management of water storage and releases from Fontenelle Reservoir. Given this management context, and based on the HGM context of information obtained and analyzed in this study, future management of Seedskadee NWR should seek to meet the following goals:

1. Maintain and restore the physical and hydrological character of the Green River (below Fontenelle Reservoir) and the Big Sandy River as best possible.

2. Restore the natural topography, water regimes, and surface water flow and flooding patterns from the Green River into and across the Green River floodplain and sheetwater runoff into and across adjacent terraces and alluvial fans.

3. Restore and maintain the diversity, composition, distribution, and regenerating mechanisms of native vegetation communities in relationship to topographic and geomorphic landscape position.

Specific recommendations to meet the above goals include actions to:

Subgoal 1.1. *Protect the physical integrity of the Green and Big Sandy Rivers and their upstream watersheds.*

Subgoal 1.2. *Cooperate with the U.S. Bureau of Reclamation to manage water releases from Fontenelle Reservoir in a more natural seasonal and inter-annual flow regime.*

Subgoal 2.1. *Restore natural topography and reconnect natural water flow patterns and pathways where possible.*

Subgoal 2.2. *Manage wetland impoundments and natural floodplain depressions for more natural seasonal and long-term water regimes based on their hydrogeomorphic attribute position.*

Subgoal 3.1. *Protect and restore native vegetation composition to upland sagebrush-steppe areas.*

Subgoal 3.2. *Restore linear bands of riparian woodland along the Green and Big Sandy Rivers.*

Subgoal. 3.3. *Restore complexes of floodplain wetland communities with natural water regimes.*

Individual actions to address each of the above subgoals are described in the report.

Future management of Seedskadee NWR should include regular monitoring and directed studies to determine how ecosystem structure and function are changing, regardless of whether restoration and management options identified in this report are undertaken. Ultimately, the success in restoring and sustaining communities and ecosystem functions/values at Seedskadee NWR will depend on how well the physical and hydrological integrity of the Green River Valley is protected and how key ecological processes and events, especially pulsed late-spring and early-summer flooding, can be restored or emulated by management actions. Uncertainty exists about the ability to make some system changes because of constraints of Fontenelle Reservoir management, water rights and historical uses, and land uses in the larger Green River watershed, including the Big Sandy River drainage. Also, techniques for controlling or reducing introduced plant species and restoring cottonwood are not entirely known. Especially critical information and monitoring needs for Seedskadee NWR include:

1. Key baseline ecosystem data on soils, vegetation inventory and mapping, animal species occurrence and abundance, and water levels.
2. Effects of attempts to restore natural water regimes and flow patterns including refinement of inundation mapping models.
3. Long-term changes in vegetation and animal communities.

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